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Effects of soccer headgear on cognitive function immediately following heading

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Effects of Soccer Headgear on Cognitive Function Immediately Following Heading

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A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

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Table of Contents

List of Tables	iii
List of Figures	iv
Abstract	v
I. Introduction	1
II. Review of Literature	5
Concussion Definition	5
Concussion Epidemiology	5
Concussion Mechanism	6
Signs & Symptoms	7
Concussion Assessment	9
Soccer Heading	12
Soccer Headgear	14
III. Methods	16
Subjects	16
Trial Procedure	16
SCAT 2	17
Heading Drills	18
Full90 Headgear	20
Statistics	21
IV. Results	22
V. Discussion	25
VI. Appendix A: Medical History Questionnaire	29
VII. Appendix B: SCAT 2 Concussion Test	30
VIII. Appendix C: Concussion Information Sheet	33
IX. Appendix D: JMU Concussion Management Protocol	34
X. Appendix E: Informed Consent Form	35
XI. Appendix F: Headgear Questionnaire	37
XII. References	38

List of Tables

Table 1: Classification of Symptoms

Table 2: Average SCAT 2, SAC, & BESS Scores by Gender

Table 3: SCAT 2, SAC, BESS Test Statistics

List of Figures

Figure 1: Sit Up Headers

Figure 2: Standing Stationary Headers

Figure 3: Target Header Locations

Figure 4: Full90 Premier Headgear

Figure 5: Average SCAT 2 Scores

Figure 6: Average SAC Scores

Figure 7: Average BESS Scores

Abstract

Concussion awareness and knowledge has increased and, as a consequence, protective equipment has been developed in an attempt to protect the athletes from sustaining a concussion. The manufacturers market the equipment as a tool to prevent concussions, yet few studies have systematically tested this hypothesis. This study investigated the Full90 Headgear to determine if performance on the Sport Concussion Assessment Tool 2 (SCAT 2) is impacted by the presence of headgear.

Subjects performed two trials, each consisting of four different heading drills both with and without the Full90 Headgear. Subjects were evaluated prior to the heading drills with the SCAT 2 concussion assessment and immediately following each trial to determine if cognitive function, concussion symptoms, or balance performance changed with heading, and if the Full90 Headgear attenuated any of these changes.

There were no changes in cognitive function, symptoms or balance performance from baseline to either of the post heading testing points. Therefore, the data indicated that purposeful heading does not change cognitive function; consequently there is no need for the Full90 Headgear to protect the athlete from a concussion during heading.

In conclusion, the SCAT 2 scores did not change from baseline in either trial (with or without headgear). As supported by others, purposeful soccer heading is not a mechanism for concussion and consequently the Full90 Headgear does not add extra protection to an athlete during heading.

Chapter I:

The Center for Disease Control & Prevention defines a concussion as “type of traumatic brain injury, or TBI, caused by a bump, blow, or jolt to the head that can change the way your brain normally works.” As the volume of research on concussion is increasing, health care professionals, coaches, athletes, and parents are becoming more aware and educated about sport related concussions. With the increase in education and knowledge, sport related concussions are becoming more prevalent.^{1, 8, 11} Although, researchers are unable to determine whether this increase is due to an actual increase in the rate of concussions or if simply that the number of concussions that are being identified is increasing. Therefore, it is important to know the signs and symptoms associated with concussions, the risk associated with each sport, the various ways to assess a concussion, and possible equipment that can decrease the risk of a concussion.

It is estimated that there were nearly 135,901 concussions sustained in all high school level sports nationwide during the 2005-2006 year¹⁵ and that during the 2009 to 2010 academic year, concussions made up 90.0% of the 1173 injuries sustained for the head, face, and neck in high school athletes.³⁰ There’s a debate as to whether there are more concussions sustained in the high school or college level. While it is believed that the rates of athletes sustaining concussions in collegiate athletics is greater, concussions make up a larger percent of total injuries in the high school level.¹⁵ Some believe that collegiate athletes suffer more concussions due to the higher intensity play and the athletes being bigger, faster, and stronger,¹⁵ but others report that high school athletes suffer more concussions due to being under developed physically, a lack of proper equipment, and an overall greater number of high school athletes.¹⁵ Regardless of which

level sustains more concussions, the number of reported concussions are most likely underestimated due to many athletes not knowing the signs and symptoms of a concussion, or the athlete being afraid to report the symptoms due to fear of not being allowed to continue to play.

Among the sports that have the highest rate of concussions American Football ranks the highest.^{8, 10, 15, 26, 31} Soccer, particularly women's soccer¹⁵, ranks high in risk for concussions due to the many injury mechanisms associated with for soccer. These include head to head, head to ground, head to other body part, head to ball, and head to stationary object, such as the bleachers or goal post.^{3, 20} One study looking at high school and collegiate athletes found that 64.1% of heading related injuries were concussions.¹⁵ Most researchers believe that though the soccer ball may be involved in concussive blows, concussions do not usually occur when the athlete is purposefully heading the ball, but instead when they are struck in the head when they are not expecting it.^{1, 3, 29} Research also suggests that purposefully heading a soccer ball does not produce enough force to cause a concussion. It is estimated that the forces necessary to cause a concussion are about $22 \text{ N}\cdot\text{s}^{-1}$, while the estimated impact of a soccer ball (at 64.37 km/h) is between 12.4 and $13.7 \text{ N}\cdot\text{s}^{-1}$, which is well below concussive levels.³⁵

Despite this research, companies have developed protective headgear for soccer players, claiming to help reduce the risk of concussions. Though the headgears may decrease the impact of the ball hitting the head; it cannot stop the brain from the sloshing effect it sustains inside the skull during impact. Studies have also shown that by wearing the headgear athletes may develop a feeling of invincibility. Tierney et al. (2008) reported that female soccer players wearing the headgear have increased head

accelerations towards the ball because they felt they needed to hit the ball harder since the headgear was taking away from the power and control that they would have without the headgear.⁴⁰ While these studies have looked at the potential forces contributing to concussions, few have looked at the impact of heading a soccer ball on symptoms, cognitive function and balance.

The purpose of this study is to determine if commonly performed heading drills (i.e. typical for a normal practice session) will have an effect on symptoms, cognitive function and balance. Additionally, we will assess whether or not the Full-90 soccer headgear protects the athlete from these impairments. We hypothesized that there would be no increase in symptoms, no decrease in cognitive function and no balance problems following 20 minutes of heading without headgear; therefore the Full-90 soccer headgear will not have any protective effect.

The limitations of this study are that the subjects were self-reporting symptoms for the SCAT -2 Concussion Assessment Test. Self reporting of symptoms is problematic in that we have no way of validating their symptoms. The, SCAT -2 concussion test itself is a newer assessment tool for medical professionals and has been used sparingly in research because validity, reliability and clinical relevance of this composite test have not been determined. Due to time constraints, limited availability of adequate facilities and required subject experience, the sample size is very small. Finally, the results cannot be generalized to game situations since we were not using game like ball speeds and the results cannot be generalized to the youth population since all subjects were of college age.

The delimitations of the study are that we did not use the youth population due to liability reasons, as well as, skill level of young children not knowing how to head the ball properly putting them at a higher risk for injury. We chose to throw the ball instead of kicking the ball since we could not be certain that the ball would go where it needed to be in order for the subject to head the ball, so we were unable to recreate game like play; nor were we able to locate a JUGS machine that would propel the ball to the subject at a specific speed, location, and angle each time allow for more game like situations.

Chapter II:

Concussion Definition:

While concussion has been defined numerous ways, the definition endorsed by most experts in sport-related concussions is “a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.”³¹ A more useful part of this definition is “a trauma-induced alteration in mental status that may or may not involve LOC [loss of consciousness].”³¹ There are many mechanisms that have been identified as causing a concussion. A direct blow to the head, face or neck and an indirect blow to somewhere else on the body that transmits force to the head are the most common mechanisms of a concussion.^{11, 27, 29}

Concussion Epidemiology:

An estimated 300,000 sport-related concussions occur annually in the United States.^{15, 26} Marar et al (2012) studied twenty different sports through 2008-2010 and 14,635 injuries were reported with 13.2% being concussions.²⁶ While Dick et al (2007) reported that concussions make up 8.6% of all game injuries and 6.0% of severe injuries that resulted in ten or more days held out from participation.¹² The number of sport-related concussions has continued to increase as the education and awareness about concussions has continued to develop. Even with increased education, many concussions still go undiagnosed. Delaney et al (2002) found that 63% of athlete who were surveyed had experience some kind of concussion related symptom throughout the season.¹¹ With these findings it's imperative that medical professionals be aware of the many signs and symptoms, the mechanisms, the proper way to assess, and the appropriate management of concussions.

In soccer there are more subtle hits than the large hits that you see in American football. A study following the injuries in 25 different high schools from 1997-2008 found that most concussions at the high school level are sustained during football (41%) followed by girls' soccer (22%).²³ Other studies have found similar findings; placing girls' or women's soccer only behind football, boys' ice hockey, wrestling, and boys' lacrosse.^{7, 15, 30} Soccer ranks high in the risk for concussion due to the many mechanisms that a soccer player is susceptible to.

There have been noted differences between males and females as far as concussion rates¹⁴ and biomechanical factors. One study looking at rate of concussions found that females have about twice the rate of concussions than that of their male counterparts who are playing similar sports.²² Some have speculated that this difference is because females are more willing to report their signs and symptoms.²³ Some believe that the difference in concussion rates is based on society and its culture. As a society, females are treated different and looked at as a vulnerable and weak making society want to protect them more. Also, society tells children that it's acceptable for females to cry over an injury while males are taught to be tough, which can lead to male athletes not reporting their symptoms.¹⁵ Given that society has its own beliefs about how male and females should act it's only fitting that it is reflected into sports and how an athlete should or shouldn't deal with injuries, as well as, their choice of style of play.^{13, 15}

Concussion Mechanism:

The most common way that a soccer player sustains a concussion is hitting head-to-head with another player followed by head to another body part (e.g. foot, elbow, knee) or head to object (e.g. ground or goal post).^{1,10,12,22,25,26,31,38} There is some

stipulation that contact with the ball or heading the ball may also be a mechanism for concussions. One study stated that female soccer players were more likely to sustain a concussion resulting from contact with the ground or the ball than their male counterparts.¹⁰ While it is stated that concussion can occur by contact with the soccer ball, it is unclear if purposeful heading is the mechanism behind the concussion. Contrary, many studies are showing that purposeful heading is not a mechanism of concussion in soccer players, but instead when an athlete is hit unexpectedly by a soccer ball that they are not purposefully trying to head.¹

When an athlete is struck unexpectedly, they are unable to protect themselves from the blow and a whiplash effect occurs through the head and neck. While purposefully heading a soccer ball an athlete can use their neck musculature as well as their core muscles to help absorb impact forces and decrease the whiplash effect on the brain. It's also been noted that males and females have biomechanical differences which can also affect concussion rates.^{13, 15, 22, 23} Some of these differences include head to ball size ratio, head to neck size ratio, and angular velocity.²² By having smaller heads and weaker neck muscles it puts females at a greater risk for sustaining a concussion since they cannot dissipate the force of the ball as well. With stronger neck musculature an athlete can better prepare for impact by pre-firing the muscles to counteract the forces from the ball.

Signs & Symptoms

There are many symptoms that are associated with a concussion, though most who have suffered a concussion report many of the same symptoms. Signs and symptoms are usually placed into a category, although not all researchers use the same number of

categories. Daneshvar et al (2011) used seven different categories that included: physical signs, behavioral changes, cognitive impairments, sleep disturbances, somatic symptoms, cognitive symptoms, or emotional problems.¹⁰ While McCrory et al (2008) used five categories that included: symptoms, physical signs, behavioral changes, cognitive impairments, and sleep disturbances.²⁷ For the purpose of this paper symptoms were classified into three categories to simplify them, the categories included: physical symptoms, cognitive symptoms, and behavioral changes. (Table 1)

Table 1: Classification of Symptoms

SCAT 2 Symptom Evaluation	
Category	Symptoms
Physical Symptoms	Headache, "Pressure in head", Neck pain, Nausea or Vomiting, Dizziness, Blurred vision, Sensitivity to light & noise
Cognitive Symptoms	Feeling slowed down, Feeling like "in a fog", "Don't feel right", Difficulty concentrating, Difficulty remembering, Confusion, Drowsiness
Behavior Changes	Fatigued or low energy, Trouble falling asleep, More emotional, Irritability, Sadness, Nervous or Anxious

In most cases the most common symptom reported following a concussion is a headache^{15, 26, 30, 31} followed by dizziness/unsteadiness and difficulty concentrating^{15, 26, 29, 30} Many concussions symptoms present rapidly and resolve spontaneously, some which may never even be recognized by the athlete nor observed by coaches or athletic trainers.¹⁰ While the public associates concussions with a loss of consciousness and amnesia, rarely do those symptoms occur. In fact, Meehan et al reported that only 4.2% of concussions result in a loss of consciousness and 21.6% result in amnesia.³⁰ While Guskiewicz et al

reported that only 8.9% of concussions resulted in loss of consciousness and 27.7% have amnesia.¹⁷

Though the awareness of how damaging concussions can be has increased, many athletes fail to report the symptoms that they are experiencing. The most common reason why athletes do not report their symptoms is because they are unaware how serious their symptoms are, that the athlete believes the symptoms are secondary to another injury, or that the athlete has a fear of reporting symptoms due to not wanting to lose playing time or to the fear of letting down their coach and/or team.^{1, 6, 29}

Concussion Assessment:

In the last 15 years, concussion assessment tools have also increased in number as researchers continue to try to identify tools that are sensitive enough to identify small alterations in brain function, yet easy to administer and interpret. Some of these tools include the Standardized Assessment of Concussion test (SAC)¹⁴, Sport Concussion Assessment Tool 2(SCAT 2), Balance Error Score System (BESS)¹⁸, Modified BESS Test, Finger to Nose Test (FTN), symptom scores, and the use of computerized tests such as the Impact⁸, Axon, and Headminder. When surveying athletic trainers on which concussion assessment they use most often when evaluating a possible concussion, most use a symptom score (85%) while 75% use computer based testing. Sixty-eight percent said a standardized test would be helpful.³³ The SCAT 2 is a widely known and recommended concussion assessment tool. This concussion assessment tool is recommended for use by the Federation International de Football Association, the National Collegiate Athletic Association, and the Center for Injury Prevention and Control. It is easily administered by medical and healthcare providers for concussion

assessment. The SCAT 2 combines a number of the previously mentioned tests in an attempt to create a more comprehensive assessment. It consists of a symptom score, SAC test, modified BESS test, and a FTN test.³⁴ The SCAT 2 thus integrates evaluation of the major areas of impairment including symptoms, cognitive function, behavioral changes, balance and emotional symptoms.¹⁰ The SCAT 2 total score has not been validated nor has a significant change score for clinical interpretation been identified, thus limiting the value of the tool and presenting numerous opportunities for further research.^{27, 28}

Though the SCAT 2 as a whole lacks validity and reliability, individual sections of the test have good validity, acceptable sensitivity and high reliability. Barr & McCrea (2001) showed that an athlete with a suspected concussion, on average, will demonstrate a 4 point drop in their SAC score and that a 3 point difference during repeated tests is 90% sensitive at identifying a concussed athlete, while a 2 point difference is 84% sensitive.²

The FTN test was determined to be reliable through studies that tested it by using the same examiner each time and found that each test yielded similar results.³⁵ One limitation to the FTN test is that the times of the FTN change when a person has been exercising. This could affect the utility of this as a concussion test if it is administered immediately after injury and before the athlete has had a chance to “recover”.³⁹ Although, the FTN test is not validated it is still reliable in the sense that a medical professional will may see a drop in score when an athlete has sustained a concussion. It cannot be the only test administered to the athlete, but it is another test that can be utilized to test the function of the athlete.

The BESS test is a series of three different stances, double leg, single leg, and tandem performed on two different surfaces. The athlete is evaluated on their ability to maintain quiet standing while errors are counted for 20 sec. While the BESS test may be somewhat predicated on the evaluators ability to accurately count errors, it has been validated against a gold standard test, the Sensory Organization Test (SOT). This test measures an athlete balance via a force plate system that detects changes in the center of pressure as an athlete is standing still on a fixed platform. Guskiewicz, Ross, & Marshall (2001) compared concussed athletes using both the SOT and the BESS test. They found a high correlation between performances on the two tests in athletes who sustained a concussion. In the study, the SOT showed a trend of worse performance scores day one post injury and by day 3 post injury the scores were beginning to return to baseline. The same trend was shown when using the BESS test.¹⁶ This shows that the BESS test is reliable by demonstrating that the BESS Test has similar results as the SOT, a medical professional can be confident that they are identifying similar results in their concussed athletes. Though the SOT is the gold standard for post concussion balance testing, the BESS test is a much more practical assessment for most medical professionals because it is less expensive, less time consuming, and can be performed in many different locations. The SCAT 2 uses a modified BESS test by only including tests of the three stances on firm surfaces. By not including the foam surface conditions, the validity of the BESS test on the SCAT 2 form may be compromised or less valuable as more errors typically occur in the harder foam surface conditions, even when not concussed.

The symptoms experienced by those who have suffered a concussion can vary a great deal depending on the athlete. A symptom score list is a good way to quantify these

symptoms and know throughout the recovery how they may be improving or worsening with each day. Lovell et al (2006) completed a study using the Post-Concussion Scale (PCS), which is very similar to that of the SCAT 2 symptom scale, in which they developed normative values for the symptom scale and tested concussed athletes as to where they fell among the norms. They found that in healthy (non-concussed) males a score of 27 or higher were classified as “extremely high” and in healthy (non-concussed) females a score of 44 or higher were classified as “extremely high”.²⁴ In males those who scored between 1-5 and females who scored 1-9 were considered “broadly normal”²⁴, these normative values show that in a typical day for any given person they may have symptoms that appear on a concussion symptom scale. It is valuable to have normative data on symptom scales, but it must be taken into consideration that symptoms are highly subjective to the athlete and that females tend to report more freely the symptoms that they are experiencing.

While there is quality research on the subtests of the SCAT 2, there lacks research on the composite score of the tests which comprise the SCAT 2. This lack of research limits the value of the SCAT 2 as a clinical and research tool. Normative values that identify the expected deviation from baseline in concussed athletes as well as expected recovery to normal needs to be identified to make this tool most useful to clinicians.

Soccer Heading:

The notion that purposeful heading will not produce a concussion is supported by heading specific research.¹² Stalnacke & Sojka (2008) looked at the S-100B calcium binding protein that increases in concentrations in the serum during brain tissue damage. In the study they had subjects head a ball falling from a height of 18 meters, 5 times and

these headers did not cause an increase in the brain injury marker.³⁸ Another study examined what the necessary impact force for a concussion to be sustained and they found that it was about 22 N-s-1, but that the impact of a soccer ball traveling at 64.37 km/h was only 12.4-13.7 N-s-, well below concussive levels.³⁵ While Kontos et al (2011) found that there was no relationship between heading and neurocognitive performance or symptoms as measured by the ImPACT concussion assessment computerized test. The ImPACT scores were similar for all subjects groups including; low, moderate, and high heading groups.²¹

Another theory is that long-term heading, such as career soccer playing, may lead to long-term cognitive impairments. One study examined the effect of chronic heading by comparing cognitive function of college soccer players to a student control group. Results suggested that no difference in baseline neuropsychological tests or cognitive function following 20 minutes of aggressive heading of the soccer ball.³ Matser et al. surveyed professional Dutch soccer players and they saw a correlation between the number of headers the athlete reported and a lower score in verbal/visual memory and focused attention. Also, as the number of concussions increased, there was a decrease in accurate visuoperception and sustained attention. However, this study has methodological flaws in that the researchers admittedly did not control for automobile accidents nor alcohol consumption, both of which can affect memory, attention, and perception.²⁵ Webbe & Ochs (2003) found that players that reported high amounts of heading had a weaker neurological performance, but the differences were not statistically significant.⁴¹ Janda, Bir, & Cheney (2002) followed youth soccer players over a two year period and found an inverse relationship with verbal learning and number of head

impacts.¹⁹ While some research suggests that long term heading may have detrimental effects of cognitive performance, many of these studies had methodological errors that may have compromised their results. Nonetheless, additional research needs to be done to determine if heading a soccer ball can potentially cause long term cognitive impairments.

Soccer Headgear:

With conflicting research regarding the potential of heading a soccer ball causing long term cognitive impairment, it's not surprising that headgear has been developed to help protect athletes. The research also presents mixed results in regard to whether or not the developed headgear helps attenuate the force of an impact sustained in soccer. One study had headgears attached to a force plate and the soccer ball was shot at the force plate at 35 mph and it showed that the peak force of the ball hitting the headgear was decreased.⁵ Despite this finding most headgear research shows that there is no decrease in risk of concussion²⁹ and that the impact from the ball is not reduced by the headgear.^{9,29,32,43} Not only is the impact not reduced, some studies found that when girls or women wore the headgear, an increased head acceleration occurred, putting them at a greater risk for concussions.⁴⁰ This increase in head acceleration has been explained by two theories. First, athlete's may believe that in order to get the same control and contact with the ball as they would without the headgear, they must strike the ball harder while wearing the headgear. Second, they may believe that since they have the extra protection, they are less vulnerable to injury and can be more aggressive when heading the ball.⁴⁰ Another studied suggested that the headgears might increase the number of headers per game and practice due to a false seen of invulnerability to the athlete.³

Needless to say, more research needs to be done on whether or not soccer headgear decrease the risk of concussions or possibly increases the risk of concussions.

As stated before there is a lot of concussion research currently being conducted; this includes research on injury mechanisms, epidemiology, evaluation and treatment, return to play and prevention. The hope is that by improving protective equipment the overall rate of concussions will decrease and medical professionals will be prepared for when the equipment fails to do completely protect the athlete.

Chapter III:

Subjects:

19, male (13) and female (6), 18-25 year-old soccer players' were recruited from the club soccer teams at James Madison University. Secondly, James Madison University students who frequently participate in recreational soccer were recruited. All subjects had at least 5 years of competitive soccer and heading experience.

Participants completed a medical history form prior to inclusion in the study (see appendix A). Exclusion criteria included a concussion within the last year, reported neurological deficits, orthopedic limitations, diagnosis of attention-deficit disorder or attention-deficit hyperactivity disorder, or if their baseline symptom score on the SCAT 2 (Standardized Concussion Assessment Tool 2) Concussion Assessment were greater than five. Those who were included in the study signed an informed consent form approved by James Madison University's Institutional Review Board. Two subjects did not complete both trials, therefore their data was removed. One subject withdrew due to an unrelated back injury and the other self-selected to seek medical treatment for a headache. According to our concussion criteria they did not sustain a concussion and their data was not included.

Trial Procedure:

Each participant was evaluated with a SCAT 2 Concussion Assessment test before heading trials and after trial 1 and again after trial 2 (3 total SCAT 2 assessments). To avoid the learning effects of the SCAT 2 we used alternative word and number lists each time a SCAT 2 was administered to assure that the subject was not memorizing the test. Each SCAT 2 took approximately 10 minutes (see appendix B). The SCAT 2

consists of eight sections that the participant answered questions on regarding symptoms, cognitive functioning, and performed a balance test. It is comprised of previously used concussion assessment tools combined into one and is recommended for use by health care providers as a concussion assessment tool. Each participant completed two trials that were one week apart; each session lasted approximately 40 minutes (including the SCAT 2 assessments). Participants were randomly placed in to two groups. Group A performed their first trial without the headgear and Group B performed their first trial with the headgear. Participants then completed 16 minutes of heading drills (4 different drills) with intermittent rest, such that the entire session lasted approximately 23 minutes. Following the post-heading SCAT 2 assessments, to ensure that no further concussion symptoms develop over night after testing, an email was sent to each subject 24 hours post-heading.

One week following the first session, participants reported back for the second session, where Group A completed the drills with the headgear and Group B completed the drills without the headgear. The exact same heading drills were repeated as the first trial taking about 23 minutes to complete, with a SCAT 2 Concussion Assessment test administered immediately following the drills. After the final trial subjects filled out a questionnaire regarding their experience wearing the headgear.

SCAT 2:

The Standardized Concussion Assessment Tool 2 (appendix B) was used to evaluate cognitive function. This concussion assessment tool is recommended for use by the Federation International de Football Association, the National Collegiate Athletic Association, and the Center for Injury Prevention and Control and is easily administered

by medical and healthcare providers for concussion assessment. Participants were assessed on symptoms, orientation, memory, concentration, immediate and delayed recall, coordination, and balance. The test was administered before any heading (test day 1) to determine baseline performance and repeated after each heading session to identify any change from normal. The SAC score, pulled from sections 5 and 8 of the SCAT 2, was used to determine if a concussion was sustained during a heading session. Research has shown that a drop in two points on the SAC test one can be 84% certain that a concussion was sustained. By using this two point drop with a sensitivity and specificity of .84 we could help eliminate the likelihood of a false positive SAC test score, while still being conservative.²

Heading Drills:

The heading drills took approximately 23 minutes to complete; and were integrated with rest periods making the actual time of heading only 16 minutes. The four drills are explained below:

Sit-Up Headers:

This drill consists of the subject laying supine on the ground in a crunch position. The researcher will stand at the feet of the subject and as the subject did a sit up, the researcher will toss the ball lightly toward their head and the subject headed it back. By doing this drill it will help warm up the subject for the more challenging tasks to be performed later in the session. Sit-up headers were performed for 30 seconds, followed by 30 seconds of rest, and another 30 seconds of heading. (Figure 1)

Figure 1: Sit Up Headers



Stationary Standing Headers:

The second drill consisted of the subject standing 5 feet from the researcher and the researcher tossed the ball lightly to the subject at head level. The subject was to keep both feet on the ground and head the ball back to the researcher. This drill continued for 2 minutes and after this drill the subject had 30 seconds to rest before moving into the third drill. (Figure 2)

Figure2: Standing Stationary Headers



Moving Headers:

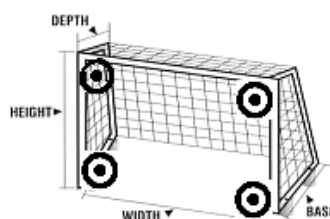
The subject stood 10 feet from the researcher and the researcher tossed the ball approximately 20 feet into the air towards the subject. The subject reacted to the ball and headed the ball at its highest point possible aiming to get it back to the researcher. This

drill consisted of two minutes of heading, followed by one minute rest, and then again two minutes of heading and one minute of rest after the heading.

Target Headers:

The last drill consisted of the subject having to head the ball at four targets that were in the top and bottom corners of a standard soccer net (Figure 3). The subject reacted to where the ball was thrown and headed it towards a self-selected corner. The drill will consist of three minutes of heading and one minute of rest for three rounds, making nine minutes total heading in this drill.

Figure 3: Target Header Locations



Headgear:

The headgear that was worn during the headgear trial was the Full90 Soccer Headgear (Figure 4). The subject was fitted for the correct headgear size and wore either the small/medium or large. At the end of the headgear trial the subject rated it on whether or not it was comfortable, if it made a difference in how they were able to control the ball while heading, if they felt a difference of impact from the ball, and if they would wear it during a game (see appendix C).

Figure 4: Full90 Premier Headgear



Statistics:

A repeated measures ANOVA was completed comparing the baseline, the post heading with headgear, and the post heading without headgear scores for the SCAT 2 scores, the SAC scores, and the BESS Test Scores. A significance level of .05 was used for all p-values.

Chapter IV:

The SCAT 2 total score did not significantly change ($F=.736$ ($n=19$)) from pre-heading to post-heading conditions both with the headgear and without the headgear (Table 2, Figure 5). The same was found for the SAC score between the headgear and without headgears trials ($F=.477$ ($n=19$)) (Table 2, Figure 6). There were no differences between baseline BESS test scores and either heading trial ($F=.230$ ($n=19$)) (Table 2, Figure 7). There were no differences between gender and two trials for neither the total SCAT 2 score, the SAC score, nor the BESS Test score ($F=.526$ ($n=19$), $F=.300$ ($n=19$), $F=.247$ ($n=19$) respectively) (Table 3). Therefore, we collapsed genders for all additional analysis.

Table 2: Average SCAT 2, SAC, & BESS Scores by Gender

Average SCAT 2, SAC, & BESS Scores by Gender			
Average Total SCAT 2 Scores			
	Baseline	With Headgear	Without Headgear
Females	94.67±2.1	94.00±2.6	93.17±3.3
Males	92.38±2.7	92.77±4.0	92.96±3.0
Average SAC Scores			
	Baseline	With Headgear	Without Headgear
Females	27.50±2.4	27.33±2.7	28.17±1.8
Males	26.11±2.0	27.62±1.9	27.26±1.5
Average Modified BESS Scores			
	Baseline	With Headgear	Without Headgear
Females	28.33±1.2	28.83±.8	28.17±1.0
Males	27.15±1.6	28.00±1.7	27.46±2.0

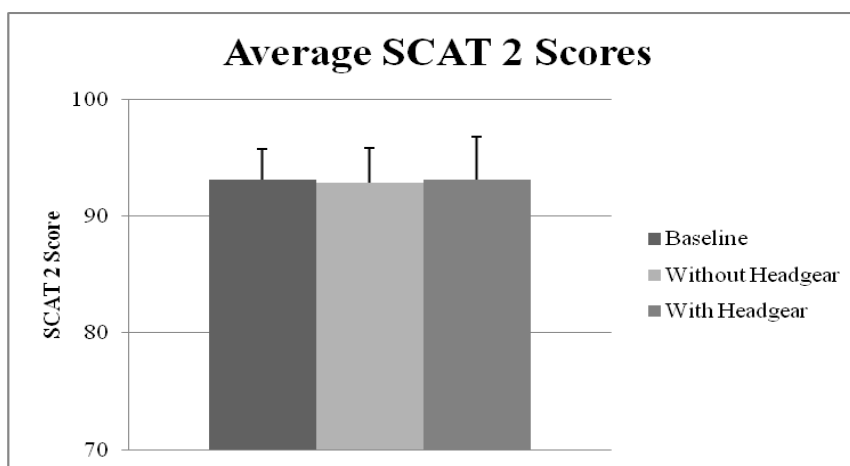
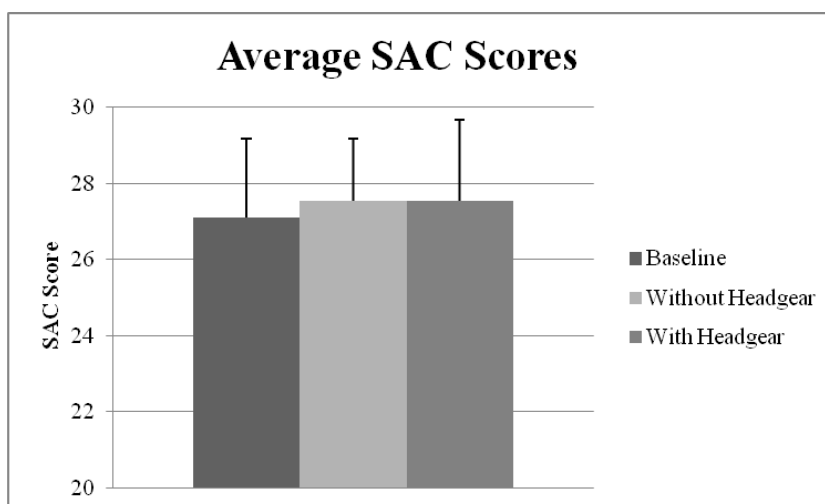
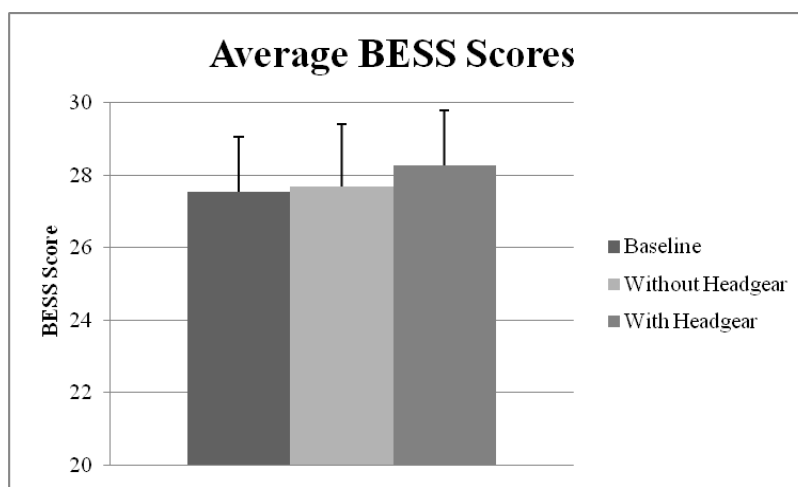
Figure 5: Average SCAT 2 Scores*Figure 6: Average SAC Scores**Figure 7: Average BESS Scores*

Table 3: SCAT 2, SAC, & BESS Score Statistics

Total SCAT 2 Score Statistics	
	p-value
Between Trials	0.736
Trials & Gender	0.526
Baseline & No Headgear	1.000
Baseline & Headgear	1.000
Headgear & No Headgear	1.000
SAC Score Statistics	
	p-value
Between Trials	0.477
Trials & Gender	0.300
Baseline & No Headgear	0.825
Baseline & Headgear	0.930
Headgear & No Headgear	1.000
BESS Test Score Statistics	
	p-value
Between Trials	0.230
Trials & Gender	0.845
Baseline & No Headgear	1.000
Baseline & Headgear	0.360
Headgear & No Headgear	0.370
<i>No significant differences ($P < .05$)</i>	

When comparing the total SCAT 2 score of the headgear trial and the without headgear trial using a pairwise comparison with a Bonferroni adjustment, we found that the scores did not significantly change ($p = 1.0$ ($n=19$)). When comparing the SAC score between the headgear and without headgear trials, there also was no significant change ($p = 1.00$ ($n=19$)) (Table 3).

Chapter V:

Our results show that purposeful heading without the Full90 Headgear did not produce any decreases in cognitive function as measured by the SCAT 2, or either subtests the SAC and BESS Test. Under our testing conditions, the Full90 headgear is not needed to reduce the risk for concussion since impairments were not produced during the heading drills.

For this study, the SAC score was used to determine if a concussion was sustained. A drop of two points or more was used to determine impairment (concussion). Research has shown that a drop in two points on the SAC test one can be 84% certain that a concussion was sustained. By using this two point drop with a sensitivity and specificity of .84 we could help eliminate the likelihood of a false positive SAC test score, while still being conservative.² None of our subjects had a decrease from baseline of more than two points during either trial. Therefore, we believe our results are consistent with previous studies who found that purposeful heading does not cause a concussion.^{12,36,38} Furthermore, our BESS Test results were similar to those observed by Broglio et al (2004) who tested subjects with the BESS test before and immediately following heading drills. Their results showed no significant difference in the balance following any heading drills. Collectively, these results suggest that acute soccer heading does not affect cognitive function, balance, or postural stability in athletes. Some studies even found that females who wore the headgear had an increased head acceleration while heading because they felt they needed to compensate for headgear taking force away; which could put them more at risk for concussions.⁴⁰ The subjective feedback from our

subjects, while not analyzed in this study, was that the headgear was uncomfortable and caused painful rubbing and was not preferred.

The use of the SCAT 2 has been recommended by numerous governing bodies even though it has yet to be validated and cut off values indicating impairment yet to be identified. While the total test lacks this information, a subtest of it have been validated and norms have been established for the scores suggesting when a concussion has occurred and what normal fluctuations in the score can be throughout a typical day. Not only do scores change throughout the day, but physical activity or exercise can lead to a change in assessment scores as well.^{9,37,42}

To allow medical professionals to assess a concussion in the best possible way, research needs to be conducted to develop norms for the total SCAT 2 score as well as identifying statistically significant changes from the norms, which suggest impairment. This information exists for the SAC Test (a subtest of the SCAT 2), while the BESS Test and the FTN Test correlate strongly with other standardized tests. By having guidelines and normative values to follow, medical professionals can make proper concussion management and return to play decisions easier. By using a tool that has multiple assessments in one, such as the SCAT 2, medical professionals can be certain that they are evaluating multiple functions of the athlete during one assessment. Research has shown that a concussion can affect many aspects of an athlete all of which may decline independently of each other including balance, cognition, coordination, and memory. The SCAT 2 is one of the first concussion assessments that evaluates multiple areas (symptoms, cognitive function, coordination, and balance) of possible impairment, while previous tests like the SAC test only assess one or two possible areas of impairment.

While the knowledge and education on concussion assessment has continued to increase among medical professionals, it is imperative that those who are assessing concussions using any of previously mentioned assessments be aware of the different variables that can affect the outcomes of that test that may not be associated with a concussion. As mentioned before, exercise or physical activity^{9,42} can affect a concussion assessment as well as alcohol consumption, medication usage, and footwear³⁷. Variables such as the subject's exercise between the trials, alcohol consumption, and medications were not controlled in this study. While these limitations could have affected the total SCAT 2 score or the SAC score of the individual subjects, it is unlikely they had an effect in our study since we did not see any impairment after heading. It would have been ideal to have the subjects refrain from exercise prior to their heading trials, it was assumed that alcohol and medication usage did not affect their performance. To control any affects that footwear may have had, we made sure the subject was tested on the same floor (i.e. the gym or racquetball court floor) wearing the same shoes for all trails.

In conclusion, this study examined the affects of acute heading drills on the total SCAT 2 score and its subcomponents, concussion symptoms, SAC, and BESS scores, in efforts to show that purposefully heading a soccer ball in a practice situation does not result in an increased risk of injury, and therefore, the Full90 Soccer Headgear does not reduce a concussion risk during heading under the tested conditions. This study showed that the total SCAT 2 scores and the SAC scores were unchanged after the heading protocol without the headgear, also showing that there was no change when the headgear was worn. Future studies should test the headgears at higher ball speeds to simulate more

game like scenarios to determine if heading during a game situation has different effects than that of a practice situation.

Appendix A: Medical History Questionnaire

Answer each question to the best of your knowledge and as thoroughly as you can. If you do not know the answer to a question please answer 'unknown'.

Name: _____

Age: _____ Gender: _____ Height: _____ Weight: _____

Have you ever been diagnosed with Attention Deficit Disorder or Attention Deficit Hyperactivity Disorder?

No Yes Unknown

What is your total number of previous concussions? _____

Have you sustained a concussion within the past year?

No Yes Unknown

When was the last time? How long were you held out from activity? _____

Do you have any known neurological deficits?

No Yes Unknown

If yes, please list them below:

Do you have any orthopedic condition that would limit you from running, jumping, or heading a soccer ball?

No Yes Unknown

If yes, please list them below:

Are you or are there any chances that you may be pregnant?

No Yes Unknown

Are you currently taking any nonsteroidal anti-inflammatory medications?

No Yes Unknown

Appendix B

SCAT2

Sport Concussion Assessment Tool 2



Name _____

Sport/team _____

Date/time of injury _____

Date/time of assessment _____

Age _____ Gender ☐ M ☐ F

Years of education completed _____

Examiner _____

What is the SCAT2?¹

This tool represents a standardized method of evaluating injured athletes for concussion and can be used in athletes aged from 10 years and older. It supersedes the original SCAT published in 2005². This tool also enables the calculation of the Standardized Assessment of Concussion (SAC)^{3,4} score and the Maddocks questions⁵ for sideline concussion assessment.

Instructions for using the SCAT2

The SCAT2 is designed for the use of medical and health professionals. Preseason baseline testing with the SCAT2 can be helpful for interpreting post-injury test scores. Words in Italics throughout the SCAT2 are the instructions given to the athlete by the tester.

This tool may be freely copied for distribution to individuals, teams, groups and organizations.

What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific symptoms (like those listed below) and often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (such as headache), or
- Physical signs (such as unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour.

Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle.

Symptom Evaluation

How do you feel?

You should score yourself on the following symptoms, based on how you feel now.

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22)

Symptom severity score

(Add all scores in table, maximum possible: 22 x 6 = 132)

Do the symptoms get worse with physical activity? ☐ Y ☐ N
Do the symptoms get worse with mental activity? ☐ Y ☐ N

Overall rating

If you know the athlete well prior to the injury, how different is the athlete acting compared to his / her usual self? Please circle one response.

☐ no different ☐ very different ☐ unsure

Cognitive & Physical Evaluation

1 Symptom score (from page 1)

22 minus number of symptoms

of 22

2 Physical signs score

Was there loss of consciousness or unresponsiveness? ☐ Y ☐ N

If yes, how long? minutes

Was there a balance problem/unsteadiness? ☐ Y ☐ N

Physical signs score (1 point for each negative response)

of 2

3 Glasgow coma scale (GCS)

Best eye response (E)

No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4

Best verbal response (V)

No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5

Best motor response (M)

No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion/Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6

Glasgow Coma score (E + V + M)

of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

4 Sideline Assessment – Maddocks Score

"I am going to ask you a few questions, please listen carefully and give your best effort."

Modified Maddocks questions (1 point for each correct answer)

At what venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week/game?	0	1
Did your team win the last game?	0	1

Maddocks score

of 5

Maddocks score is validated for sideline diagnosis of concussion only and is not included in SCAT 2 summary score for serial testing.

5 Cognitive assessment

Standardized Assessment of Concussion (SAC)

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1

Orientation score

of 5

Immediate memory

"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order."

Trials 2 & 3:

"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. Score 1 pt. for each correct response. Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

List	Trial 1	Trial 2	Trial 3	Alternative word list
elbow	0	1	0	1
apple	0	1	0	1
carpet	0	1	0	1
saddle	0	1	0	1
bubble	0	1	0	1
Total				

Immediate memory score

of 15

Concentration

Digits Backward:

"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."

If correct, go to next string length. If incorrect, read trial 2. One point possible for each string length. Stop after incorrect on both trials. The digits should be read at the rate of one per second.

	Alternative digit lists
4-9-3	0 1 6-2-9 5-2-6 4-1-5
3-8-1-4	0 1 3-2-7-9 1-7-9-5 4-9-6-8
6-2-9-7-1	0 1 1-5-2-8-6 3-8-5-2-7 6-1-8-4-3
7-1-8-4-6-2	0 1 5-3-9-1-4-8 8-3-1-9-6-4 7-2-4-8-5-6

Months in Reverse Order:

"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November ... Go ahead"

1 pt. for entire sequence correct

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
--	---	---

Concentration score

of 5

¹ This tool has been developed by a group of international experts at the 3rd International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2008. The full details of the conference outcomes and the authors of the tool are published in British Journal of Sports Medicine, 2009, volume 43, supplement 1.

The outcome paper will also be simultaneously co-published in the May 2009 issues of Clinical Journal of Sports Medicine, Physical Medicine & Rehabilitation, Journal of Athletic Training, Journal of Clinical Neuroscience, Journal of Science & Medicine in Sport, Neurosurgery, Scandinavian Journal of Science & Medicine in Sport and the Journal of Clinical Sports Medicine.

² McCrory P et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. British Journal of Sports Medicine. 2005; 39: 196-204

³ McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sports Medicine. 2001; 11: 176-181

⁴ McCrea M, Randolph C, Kelly J. Standardized Assessment of Concussion: Manual for administration, scoring and interpretation. Waukesha, Wisconsin, USA.

⁵ Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clin J Sport Med. 1995;5(1):32-3

⁶ Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24-30

6 Balance examination

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[®]. A stopwatch or watch with a second hand is required for this testing.

Balance testing

"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."

(a) Double leg stance:

"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."

(b) Single leg stance:

"If you were to kick a ball, which foot would you use? [This will be the dominant foot] Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

(c) Tandem stance:

"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.** If a athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of **five seconds** at the start are assigned the highest possible score, ten, for that testing condition.

Which foot was tested: ☐ Left ☐ Right
(i.e. which is the **non-dominant** foot)

Condition	Total errors
Double Leg Stance (feet together)	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at back)	of 10
Balance examination score (30 minus total errors)	of 30

7 Coordination examination

Upper limb coordination

Finger-to-nose (FTN) task: *"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended). When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose as quickly and as accurately as possible."*

Which arm was tested: ☐ Left ☐ Right

Scoring: 5 correct repetitions in < 4 seconds = 1

Note for testers: Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. Failure should be scored as 0.

Coordination score of 1

8 Cognitive assessment

Standardized Assessment of Concussion (SAC)

Delayed recall

"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

Circle each word correctly recalled. Total score equals number of words recalled.

List	Alternative word list		
elbow	candle	baby	finger
apple	paper	monkey	penny
carpet	sugar	perfume	blanket
saddle	sandwich	sunset	lemon
bubble	wagon	iron	insect

Delayed recall score of 5

Overall score

Test domain	Score
Symptom score	of 22
Physical signs score	of 2
Glasgow Coma score (E + V + M)	of 15
Balance examination score	of 30
Coordination score	of 1
Subtotal	of 70
Orientation score	of 5
Immediate memory score	of 5
Concentration score	of 15
Delayed recall score	of 5
SAC subtotal	of 30
SCAT2 total	of 100
Maddocks Score	of 5

Definitive normative data for a SCAT2 "cut-off" score is not available at this time and will be developed in prospective studies. Embedded within the SCAT2 is the SAC score that can be utilized separately in concussion management. The scoring system also takes on particular clinical significance during serial assessment where it can be used to document either a decline or an improvement in neurological functioning.

Scoring data from the SCAT2 or SAC should not be used as a stand alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion.

Appendix C: Concussion Information Sheet

- You must be watched closely by another person for 24 hours. This could be a roommate, teammate, or a parent.
- You may eat and sleep based on how you feel. Please try and drink extra fluids. Do not drink any alcohol until you are cleared to return to participation.
- You do not need to be awakened in the middle of the night.
- If you show any of the following symptoms or signs after your head injury you or the person watching you should call your athletic trainer and go to the Emergency Room:
 - A very bad headache or a headache that is getting worse
 - Throwing up that will not stop or starts several hours after you injury
 - Any fainting spells or being more sleepy than usual
 - Confusion that is getting worse
 - Change in behavior (acting strange, saying things that don't make sense)
 - Cannot remember new events
 - Cannot move parts of your body or face; vision or speech problems
 - Seizure (any jerking of the body or limbs)
- You may use 2 Tylenol up to 4 times a day for headache or other pain.
- DO NOT take any strong pain pills, ibuprofen, or aspirin for the first 24 hours.
- You must not do any exercise, workouts, or sport activities until cleared to do so.

Appendix D: James Madison University Concussion Management Protocol

POST SIDELINES CONCUSSION MANAGEMENT:

After the competition or practice, all student-athletes who have had a presumed concussion should be re-evaluated formally. This evaluation is to use the SCAT-2 tool (sections 1, 2, 5, 6, 7, 8) and record this in their medical chart along with details of their injury. Any S-A diagnosed with a concussion at this point is sent home with a “Concussion Information Sheet” and instructed on strict cognitive and physical rest. The warning signs of a complicated concussion are also reviewed with the athlete at this time.

The Symptom Evaluation section of the SCAT-2 should be repeated daily for a total of 3 days or until symptoms have resolved whichever comes first. When the Symptom Evaluation score has returned to baseline, the S-A should undergo a complete SCAT-2 test. The athletic trainer should arrange for the team physician to evaluate the student-athlete once symptoms have resolved or if the symptoms have not resolved within 72 hours, whichever comes first. As a part of this follow up period, neurocognitive testing (ImPACT) is to be done either when the S-A is asymptomatic and has a normalized post injury SCAT-2 test or at roughly 72 hours post injury whichever comes first.

It is possible that the S-A will be asymptomatic and have a normal/baseline SCAT-2 on that first day. Because of their sidelines evaluation they are still diagnosed with a concussion but have already returned to a baseline state. They must rest for the remainder of that day and cannot return to any competition or physical activities until the following day at the earliest.

While an S-A is still symptomatic and recovering from a concussion, they are encouraged to be at both physical and cognitive rest. Activities that require concentration and attention (scholastic work, video games, text messaging, observing practice or games) may exacerbate symptoms and possibly delay recovery. The team physician may request that the S-A be excused from lectures and scholastic assignments during this period.

Appendix E: Consent to Participate in Research

Identification of Investigators & Purpose of Study

You are being asked to participate in a research study conducted by Maegan Michalik, ATC and Beth Brann, ATC from James Madison University. The purpose of this study is to determine if the Full 90 headgear on the performance of a concussion assessment tool following heading a soccer ball. This study will contribute to the researcher's completion of her master's thesis and the better understanding of the relationship between the headgear and concussions.

Research Procedures

Should you decide to participate in this research study, you will be asked to sign this consent form once all your questions have been answered to your satisfaction. You will then be evaluated with a SCAT 2 Concussion Assessment prior to 16 minutes of heading, followed by another SCAT 2 Concussion Assessment. All tests will be administered to individual participants in Godwin Gym or Lower Turf field at UREC. One week later you will repeat the heading drills and SCAT 2 Concussion Assessment and then complete a questionnaire about your experience wearing the headgear. One trial will be completed with the headgear and the other trial will be completed without the headgear.

Time Required

Participation in this study will require 40 minutes of your time during each session, for a total of 80 minutes; as you will need to participate in two sessions, one week apart.

Risks

The investigator does not perceive more than minimal risks from your involvement in this study (that is, no risks beyond the risks associated with everyday life or a normal soccer practice). However, in extreme cases there is a chance that you may sustain a mild concussion during the study. Each subject will be tested immediately following the trial and will have a telephone follow up the next day to check for any symptoms that may develop over night. Should symptoms develop you will be cared for by a Certified Athletic Trainer until symptoms clear. You will be given an at home concussion information sheet and told to watch for any signs and symptoms that may develop during the night. You will see the Certified Athletic Trainer every day following the concussion and will be evaluated using the James Madison University Sports Medicine Department Protocol for Concussion Management minus the ImPACT testing due to the cost of the test. If symptoms persist longer than 72 hours you will be referred to a physician and be responsible for any charges that may incur from the follow up care.

Benefits

The benefits to the participants in this study include a development of better understanding of concussion assessment and what is being done to decrease the risk of concussive injuries in their sport. The overall benefits of this study are that it will add to the overall body of knowledge regarding concussion prevention and assessment.

Confidentiality

The results of this research will be presented to the master student's thesis committee and may be presented at a conference or submitted to a professional journal. The results of this project will be coded in such a way that your identity will not be attached to the final form of this study. The researcher retains the right to use and publish non-identifiable data. While individual responses are confidential, group data will be presented representing averages or generalizations about the responses as a whole. All data will be stored in a secure location accessible only to the

researcher. Upon completion of the study, all information that matches up individual respondents with their answers will be destroyed.

Participation & Withdrawal

Your participation is entirely voluntary. You are free to choose not to participate. Should you choose to participate, you can withdraw at any time without consequences of any kind.

Questions about the Study

If you have questions or concerns during the time of your participation in this study, or after its completion or you would like to receive a copy of the final aggregate results of this study, please contact:

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Questions about Your Rights as a Research Subject

Dr. David Cockley
Chair, Institutional Review Board
James Madison University
(540) 568-2834
cocklede@jmu.edu

Giving of Consent

I have read this consent form and I understand what is being requested of me as a participant in this study. I freely consent to participate. I have been given satisfactory answers to my questions. The investigator provided me with a copy of this form. I certify that I am at least 18 years of age.

Name of Participant (Printed)

Name of Participant (Signed)

Date

Name of Researcher (Signed)

Date

Appendix F: Headgear Questionnaire

Please rate your experience on wearing the headgear during the drills on a scale of 1-5.

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

- The headgear was easy to put on and take off.

1 2 3 4 5

- The headgear was comfortable to wear while heading the ball.

1 2 3 4 5

- You noticed a difference of impact while heading the ball with the headgear on.

1 2 3 4 5

- The headgear gave you **more** control while heading the ball.

1 2 3 4 5

- You would wear the headgear again during a game.

1 2 3 4 5

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